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NOTES ON AIR-SICKNESS

(008)

"OFFICIAL. NOT FOR PUBLICATION"

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Royal Air Force

IMPERIAL ROYAL FLYING CORPS.

CANADA.

PERSONAL

Sir Robert Falconer,
University of Toronto,
Toronto, Ontario.

Dear Sir Robert:

I am taking the liberty of enclosing a monograph authorized for the use of Medical and Flying Officers in the R. A. F., Can. by Brigadier-General Hoare, which I think may prove of interest to you. Please do not criticize the literary side of it too severely as I fully appreciate its deficiencies.

Believe me,

Yours sincerely,

W. Mackay
---------- Major
S.M.O. Headquarters
Royal Air Force
CANADA

TORONTO
25-11-18
O'R:B

NOTES ON "AIR SICKNESS"

By. MAJOR B.R.O'Reilly. ---- Senior Medical Officer, R.A.F., Can.

A Medical Officer on being attached to the R.A.F., for duty at once encounters a series of problems which would not have presented themselves among his duties with a Battalion. Life at a "Flying Wing" presents sharp contrasts with that of Barrack or Camp, for the Medical Officer must, far more than is necessary in any ordinary arm of the service, become the confidant and advisor of both Officers and Cadets. He must have his quarters with the Officers, be a member of their "mess", mix as freely as possible with them and in his spare time talk with both Officers and Cadets on the Aerodrome or in the Squadron Offices, for it is only in that way that he can hope to acquire their viewpoint and obtain their confidence.

The first experience that will confront him on his arrival at a Wing will be that of having to refuse numerous invitations to "joy-ride", for Pilots keenly enjoy being the first to take up a new Medical Officer. If he has the slightest feeling of nervousness he should on no account go into the air until he has spent several days in camp and gained confidence from watching hundreds of machines safely raising and landing; and then only with a Pilot in whom he has complete trust and for a straight flight of very short duration. Medical Officers permanently seconded to the Royal Air Force may be required under the Air Force Regulations to go into the air if necessity arises, but this does not apply to those merely Attached to the Corps. It is hardly possible for a man to remain on an aerodrome without experiencing the desire to be taken up, and I have yet to see an Officer who has been able to resist the temptation, and more than that to find one satisfied with a single flight. After the first few ascents it is well to

be taken up on a short "cross country" trip and to ask the Pilot to do a few ordinary stunts - steep banking, spirals, "zooming" and last of all a loop or "spin"; for it is only in this way that the Medical Officer can become of real use to the Wing Commander.

A small "Casualty Clearing Hospital" is established on all Aerodromes; the requisite number of Medical Orderlies; an X-ray outfit; motor, sleigh and aeroplane ambulances are also attached, and to outlying stations are also C.A.M.C.Nursing Sisters.

Two Medical Officers at least are attached to each Wing, and it is an invariable rule that no machine may leave the ground unless one of them is on duty, nor may he leave the aerodrome while a machine is still in the air. Should, however, he become compelled to leave the aerodrome to attend a "casualty" Wing Headquarters must at once be notified; they will then immediately set the recall signal and "washout" or cease flying until his return.

I do not propose to go into the details of the duties devolving on Medical Officers in connection with ordinary camp life,sanitation, etc.= as they closely follow those laid down for general use in the C.A.M.C., but intend only to touch on the points where differences occur and the new problems which arise, nor will the questions involved in the selection of Cadet Pilots be discussed.

The term "Air Sickness" is used to cover a variety of complaints encountered only in a flying camp. These vary from the ones advanced by the malingerer to the true disabilities resulting from organic changes in the internal ear. During the recitation of the complaints and during the following examination, the Medical Officer must endeavor to "size up" the type of man with whom he is dealing, to dissect his personality and at the same time to keep constantly before himself the bearing psychology has on these problems; for it is only by a knowledge of these points that he is capable of answering the question put to him by the man's Squadron Commander"Is this man fit to fly "?

It is now that the Medical Officer's personal experience in the air proves its value, for without it it would be impossible for him to appreciate the experiences related to him and to be able to separate the true from the fictitious, or the actual from the imaginary. If possible he should have been in personal communication with the man's Instructor, should a cadet be the patient, and have a good idea of his flying capabilities and record. In order to complete his preliminary investigation, inquiries should be made into his habits and the recent history of the case; to do so all Documents, Medical History Sheets, Attestation Forms, Turning Reports, Conduct Sheets, etc., should be in his possession. Should no organic disease in connection with the General Systems be found, an investigation of the Central Nervous Mechanism should next be undertaken and finally that of the Spedial Senses. One must not expect to find evidence of organic nervous lesions in a cadet who has been recently attested, for he is presumably "A-1" physically, but the functional Neuroses are common. If such indefinite symptoms as hesitation in speech, insomnia or "flying all night", restlessness, loss of power of concentration, night-mares, frequency of micturition be the only ones demonstrable, the Medical Officer is faced with the questions - has this man Hysteria, True Neurasthenia, has he acquired the fear of flying and in the language of the aerodrome developed "wind up", (for which the author suggests the use of the term "Aerophobia"), or finally is he a Malingerer?

The problems suggested above are among the most frequent and difficult of solution that M. O's are called upon to solve, and the examiner must be absolutely sure of his ground Should there be any suspicion of malingering, before ordering the man to take to the air he should be aware of his temperament, of his flying abilities, his reasons for the deceit, and he must

in every case where the slightest shadow of doubt exists give the cadet its benefit. In these doubtful cases when no organic lesions are found, transfer to a non-flying wing where routine drill and physical training form a major part of the course will often result in a speedy recovery, especially if this so if such cadets are deprived of the ordinary "leaves", compelled to retire at an early hour in order to insure an extra amount of physical rest and also for the moral effect. If the case warrants it they should be given such fatigues as they most heartily detest. In cases of real fear with complete loss of nervous control only two courses are open, immediate discharge as unfit for the duties of the Corps, or if the cadet has already flown satisfactorily, is partially trained and therefore represents a definite financial investment to the Government, liberal leave may be considered, especially if a good reason for the loss of poise is found - for example, witnessing a serious casualty or having by a narrow margin through no fault of his own escaped a collision in the air. It is in the decision of such cases as these that the Medical Officer proves his value to the Corps, and it is easily seen that it is only by experience that this can be obtained. Take for example a cadet, whom the writer while himself in the are saw "spin" or fall out of control several thousand feet on a Canadian Aerodrome. This cadet regained partial control of his machine just above the ground and "crashed", reducing the aeroplane to fragments but himself escaping with a general shaking up. An hour later he begged to be allowed to take up another machine, but this was refused although physical examination demonstrated the absence of any injury. This decision was arrived at following an analysis of the man's mental state, and it was finally decided that he be sent on ten days leave in spite of the fact that a veiled and suppressed excitement was the only sign demonstrable. The tempera-

ment of the cadet in this case and an intuitive feeling that this period of calm would precede a storm, were the determining factors in the recommendation for leave. A week later this cadet reported to Headquarters in a highly nervous state; tremor of lips and fingers was marked, flushing of the face, hesitation in speech, quivering of the lips and before the end of the interview tears/ These symptoms only became manifest two or three days after the "crash", and in the cadets opinion if he had been allowed to fly at once, as he had originally begged, he would not have been alive; for he admitted that he was so confused that he would probably have lost control of the machine and possibly his life had he attempted a flight in his excited condition. The only alternative in this case would have been to have sent this cadet into the air for a short time on a "dual flight", the Instructor then putting the machine into a "spin" and demonstrating to him how to regain control; and this course probably in the majority of cases would have been the best. This cadet apparently had no fear of the air, but the shock which he received as a result of the crash was similar to that seen in concussion of the brain, and it was two months before this boy, who was about 20 years of age, was considered fit to be again trusted in a machine or even allowed on an aerodrome, On the other hand many cadets who have minor"crashes" due to their own carelessness or to disobedience of rules must immediately, if they are to make good, be allotted to another machine and sent into the air to carry out some definite duty. Whether it be a "dual" or a "solo" flight must depend on the judgement of the Medical Officer and the man's Squadron Commander. True Traumatic Neurasthenia is not difficult to detect as it seldom appears unless preceded by definite physical injuries. Duty for a considerable period at a "ground school" as a Technical or Equipment Officer is the only course open, and even then many of these unfortunate men never fully recover sufficient confidence to take a machine into

the air. This is more especially true in cases where the pilot's machine has been shot down "out of control" on active service and when months of hospital treatment has followed the "crash" Simple fear of the air is rarely found, the writer having seen comparatively few cases, but a "Neurasthenic Aerophobia" is not uncommon, and here again immediate discharge from the army or to another branch of the service is usually the only recourse. True Brain Fatigue and "Stress" from incessant flying, continual mental strain with little or broken sleep such as is encountered following periods of "activity" in France is seldom seen in this country, but pilots recovering or convalescing from its effects are frequently sent to Canada for a change of environment and rest. The M.O., must however remember that the strain of continuous instructional duties even under ideal surroundings is not infrequently seen in Canada, and he should remember that this strain is real and that the cummulative effects may be considerable. It should be noted as a general rule that no Instructor or cadet should fly more than 3½ hours daily for any considerable period. The responsibility of deciding whether or no a man with "Nerves" shall fly rests entirely on the shoulders of the Medical Officer, as also does the question as to whether "leave" is likely to prove of sufficient benefit to ultimately fit the man for flying. He should remember that he must look at the problem not only from the view point of the cadet wo will seldom give in and ask for his discharge, but he should also keep in mind the expense the Government would incur in paying and keeping, perhaps for months, a man who will ultimately prove valueless to the Air Force and must be discarded or transferred to the Infantry or other Arm of the Service. Passing to the Circulatory System the effects of alterations in blood-pressure should be carefully noted. These fortunately, owing to the care taken in the examinations previous to attestation, are seldom found. Low Blood-pressure is only encountered in men who are below par physically; on the other hand increases in the

pressure readings are more frequently seen and are usually easily accounted for. The previous history in the latter class of case will be found of value, especially that of an infectious fever with renal complications. These men can seldom rise to any height without feeling the effects, they usually complain of headaches, fullness or throbbing in the head, vertigo and also of epistaxis. In deciding whether a trained cadet with a S.B.P. of say 140 to 150 should remain in the Corps, the Medical Officer should always keep before him the fact that retrogression in the condition rather than improvement is the most likely sequel, and that to be fit for general service flying a cadet must be able to rise with but slight inconvenience to at least 20,000 feet, or nearly four miles. Such men may, under the most exceptional circumstances, be recommended for low altitude work or as "Ferry Pilots", but on general principles they should be discharged as a probable menace to themselves or their passengers. The effect of "Oxygen Want" on blood-pressure will be dealt with later. Let me take occasion to point out at this stage that simple diminution in Atmospheric Pressure is void of ill effects, providing that the changes are gradual. It must be remembered that rapid lowering of atmospheric tension is not found in practice since planes have not yet been built which will climb at a greater speed than approximately 1,000 feet per minute. Rapid Descents from high altitudes on the other hand frequently give rise to acute symptoms, these however are not often seen unless the pilot has reached an altitude of over 8,000 feet. The Pilot usually notices variations in the sound of the engine exhaust, cracking, discomfort or even pain in the ears, to overcome which he should hold his nose and infilate the middle ear space through the Eustachian Tube and so equalise the air-pressure on the two sides of the drum. Yawning and Swallowing movements may be used if a

hand cannot be spared to hold the nasal orifices. The above symptoms are of no special consequence as they can usually be easily avoided, but should the pilot during a rapid descent notice first a fullness in the head followed by throbbing, a splitting headache and sense of bursting, he should immediately climb until the sensations are relieved, as it is obvious that persistence in the descent might render him unable to control the machine; he may then after he has recovered gradually approach the lower altitudes. Not infrequently such headaches as described above persist for hours and may be even accompanied by severe attacks of Nausea or Vomiting. Finally it should be noted that when two men are subjected to the same rarity of atmosphere in a "Low Pressure Chamber", if one of them be supplied with Oxygen through a tube and the other ignored, the latter only will complain of symptoms, even when they are both in an atmosphere which corresponds to say 24,000 feet. Vertigo may be due to a variety of causes and be either temporary or permanent, the former however being the most frequent. It is usually if not always the percursor of a syncopal attack, and also frequently of anaemia. Simple digestive disturbances are by far the most common causes of dizziness and should be treated along recognised lines, but on no account must a man be allowed to fly until all symptoms have disappeared for at least 7 days and then in a dual machine for a further short period. It is quite common to find excessive tea and coffee drinking or nicotine poisoning to be the direct cause, and it may be noted that other excesses may also be contributory factors in determining the attacks. Vertigo may precede syncopal attacks for some time, so that men showing this symptom must be most carefully watched and the cause sought out. Increased blood-pressure, "oxygen want", vaso-motor disturbances, wax in the ears, eye-strain, etc., should of course always be eliminated as etiological factors. The Vertigo suffered by cadets when learning to "spin" and "spiral" is usually transient

quickly overcome by practice and is due to movements set up in the semi-circular canals in one definite direction. All cad ts must be instructed should they feel it, to make short jerking movements of the head in the opposite direction to that in which the plane is rotating, in order to neutralise or arrest excessive currents in the fluid of the canals in the one direction. It might be noted that this manoeuver is practiced by "Whirling Dancers" in order to prevent the onset of dizziness. Vertigo resulting from derangements of the Internal Ear on the other hand is frequently permanent and secondary to Syphilis or Organic Central Nervous lesions. These conditions act through its nervous mechanism, syphilis indeed attacks in some cases the VIII Nerve as early in the disease as the appearance of the secondary symptoms so that the diagnosis in occasional cases may be confirmed by "rotation tests" It is impossible to go into in any detail in these notes the intricate technical problems involved in the study of Vertigo but the medical reader is referred to the recent publication by I.H.Jones on Vertigo and Equilibrium for a wealth of detail. For the information of the Flying Officer a short explanation of the phohomenon of Equilibrium may not be out of place. Deep in the bones of the skull in close connection with the hearing apparatus lies one set on each side, a series of three minute canals fille with a clear fluid and lined with a membrane intimately connected by delicate nervous elements with the brain. These canals each correspond to half of a the arc of a circle, are about ½ of an inch in length, have a diameter of about 1/20 of an inch and at one extremity communicate with each other the free ends terminating in bulbous enlargements. They lie in the three dimensions or planes of space and it is primarily due to movements in the contained fluid acting on the delicate nerve terminals, which are directly connected with the brain through fibres of the VIII Nerve, that man is enabled to maintain

the equilibrium of the body. It may be of interest to note at this point that the corresponding system in birds shows the extremely high degree of development one would expect. Knowing that to be a successful pilot a man must have an accurate and delicate perception of his position in relation to the earth, its adjuncts, and the problems involved in aeronautics are related. It should be understood that the canals mentioned above have nothing to do with the sense of hearing. Close to these canals and in the same portion of bone lie two other channels closely resembling the spiral canals found in conch shells, and it is on these canals also filled with fluid and lined with cells connected to the brain by fine nervous filaments, that we rely for our auditory impressions. It has been proved that not only for dizziness but also nausea and vomiting, all untoward symptoms frequently encountered in Airmen, are closely connected with lesions or functional disturbances of the auditory labyrinth. In order to test the functioning of these canals, the contained fluid may be set in motion by rotating the body. This is most readily done by seating the patient in a revolving chair and so with the head in different planes testing the canals in turn. It has been found that pilots experiencing difficulty in flying, especially in maintaining equilibrium and those who are troubled with vertigo or nausea, often show abnormal reactions, and it is for this reason that these "Rotation or Turning Tests" are used. They have been employed for a considerable time in connection with diseases of the internal ear and in the diagnosis of lesions of the brain, but it is only recently, as a result of experimental work, that their application to aeronautics has been demonstrated and proved to be of practical value. In the "Nystagmus Test" the applicant is first spun in the chair exactly ten times in twenty seconds, accurately checked with a stop-watch. The examiner now carefully observes certain lateral jerking movements of the eyes which normally appear and should cease in approximately 26 seconds. A certain variation is allowed from this standard, and C.A.T.S. for Pilots not

conforming to this test should not be allowed to fly. In it the head is tilted forward to an angle of thirty degrees in order to stimulate only those canals which lie in the horizontal plane. In order to stimulate those canals lying in the vertical plane "Falling Tests" are employed. The subject is instructed to lean forward resting his forehead on his hands which are placed on his knees and is then turned alternately to right and left five times in ten seconds. Should he be rotated to the right and be ordered to sit up, he should immediately fall to the right, which is the normal re-action, but should he sit directly upright or fall to the opposite direction, a faulty functioning is thus demonstrated. "Pointing Tests" are applied somewhat similarly. The candidate is turned ten times in ten seconds alternately to right and left with eyes closed. He is then instructed to raise his arm and point to a fixed object, usually the examiner's finger, the position of which he is already aware. As a result of the dizziness produced, if he has been turned to the right, he should point to the right of the object. This "Past Pointing" is a normal reaction and any considerable deviation should immediately reject the applicant. Even after the chair has stopped the man still feels that he is turning and is endeavoring to locate the fixed point, the "Past Pointing" shows that he is endeavoring to allow for the rotary motion which he is still experiencing, though actually the chair is stationary. Since the more sensitive theoretically a man is, as shown by "Turning Tests" the more likely he is to be a good pilot, since he should be able to detect more accurately and early the movements of his plane without the use of his eyes. This is however true only to a limited degree, for we have found that as a rule the higher the Nystagmus time the more likely is the man to suffer from vertigo, nausea or vomiting in the air. On the other hand, theoretically a man with a short period of Nystagmus should be less sensitive to unpleasant subjective sensations and those with "Dead Labyrinths" ought to be immune. The practical deduction

is that in good pilots the ocular oscilations must not vary to any considerable extent, say not more than 10 - 12 seconds; on the other hand the lower or shorter the Nystagmus time the better a man should be able to stand the violent swaying of a Captive Balloon, since it is this motion above all others that produces the most intense nausea and emesis. Following the above to its logical conclusion we in practice reject men who show too high a Nystagmus time and recommend for Observers and especially for Balloonists those showing sluggish reactions.

It has been shown recently that Syphilis attacks very early in its course the terminal filaments of the VIII Nerve or that supplying the internal ear, apparently the toxine having a selective action. As a result of this knowledge certain cases of early syphilis have been detected, and from the point of view of the Air Force this has an important bearing, for it is obvious that no man who has contracted syphilis should be allowed to fly while under treatment, not only for the reason that his equilibrium may be effected, but also having in view the possibility of a drug toxaemia developing and interfering with the normal action of the semi-circular canals through the blood stream. In ordinary cases should the "turning tests" be doubtful or inconclusive it is quite in order to send the candidate for a "trial flight", If he has not flown before this should be of very short duration and no stunting allowed; in fact no cadet should ever be stunted on his first flight as unquestionably many good pilots have been lost to the Force as a result. This preliminary ascent should be followed by a longer one. The cadet should then be ordered to look directly down over both sides of the plane for a period of at least one minute, then to lean back in his seat and look past the trailing edge of the top plane, finally to turn and look alternately over his shoulders directly back and toward the tail; his condition meanwhile being carefully watched by the pilot who should sit in the back seat. A Medical Officer must be on the aerodrome and examine the man both

before and after each flight, noting particularly his pulse and nervous condition. During the second trip if the procedure outlined above gives no untoward results the pilot should do a few "zooms", "vertical banks" and finally if the cadet is in good condition put the machine into a "spin". Many toxaemias have an effect on the internal ear mechanism, so that the examine should not as a rule reject an applicant on a single test, unless he has eliminated fatigue, constipation and other minor disabilities which might temporarily effect the rotation tests. It is obvious that a pilot must have a healthy set of semi-circular canals and a normally functioning "Muscle Sense" mechanism to be able to fly in a x fog or cloud or to qualify as a "Night Pilot", for in these instances he is to all intents deprived of his sense of sight in so far as it would aid him in recognising his relation to the earth. Cases have been reported where pilots have emerged from a cloud with the plane flying on its back and have been unaware of their position, unfortunately no genuine cases have been encountered in this country which could have been "Turned" and the condition of their Labyrinths investigated. It has been our practice from the beginning in the examination of Recruits to reject those who show marked asymmetry in their turning tests, as well as those showing an abnormally short or long Nystagmus time, and from practical experience the wisdom of this procedure has apparently been justified.

While it is necessary that pilots have an acute and correct position of balance this does not apply to the same extent to Observers. Even if an observer fails to come within the arbitrary limits set for the pilots tests, providing that he experiences no nausea or vomiting in the air and does not become giddy on "stunting" he may be accepted without hesitation. It is now recognised that disturbances of the internal ear mechanism are responsible for most if not all cases of sea-sickness, and that many of these cases however are temporary and easily overcome, is conceded. It is to this class that men belong who, while suffering from nausea early in their flying career, ultimately become immune.

I am indebted to Capt. W. G. Mackechnie, who is in charge of the "Rotation Tests" at R.A.F., Can., Headquarters, for the case sheets of several pilots, of which I am giving a resume in order to point out the practical application of the "Turning Chair" -

Case 1 - R.A.F., Can.155905:

This cadet was given one hour and thirty five minutes dual flying and reached a maximum altitude of 2,500 feet. He showed persistent vomiting and on this account was sent to Headquarters for interview. The date of his attestation preceded that on which the "Turning Tests" were required for all candidates for admission to the Corps. It was found on examination that his Nystagmus to the right and left was 29 and 27 seconds, that his Pointing Tests were confused, and that on turning to the right he fell to the left and vice versa. Had this cadet been turned at the time of attestation he would not have been accepted as a pilot.

Case 2 - R.A.F., Can.158106:

This pilot also was accepted prior to the institution of "Rotation Turning" on attestation. He was given three hours dual flying, but never flew solo. The greatest altitude reached was 4,000 feet. On several occasions he fainted in the air and showed marked sickness on landing. He was returned to Headquarters with request for examination. He showed slight swaying and in addition was also nervous and had a marked tremor of both hands. His Nystagmus to the right and left was 40 and 35 seconds. His Pointing Tests were normal, but his falling was very slight to the right and markedly exaggerated to the left. On turning he became extremely pale showing marked nausea, tremor and profuse vomiting. He also would never have been attested had he been turned at the time of his original Medical Board.

Case 3 - R.A.F., Can. 158091:

The same preliminary remarks apply to this cadet, who was given seventy-five minutes dual flying, but no solo instruction. He fainted in the air, complained of dizziness and also much emesis on reaching the ground. The greatest altitude reached was 5,000 feet. He showed no Rhomberg ism. His Nystagmus to the right and left was 42 and 40 seconds. His Pointing was normal. His falling was in the right direction but was markedly exaggerated, even to the point of falling out of the chair. He showed marked nausea and vomited after each rotation and it was difficult to finish his examination. He too was unfit originally as a cadet from the point of view of Aviation.

Case 4 - R.A.F., Can. 74965:

This cadet had six hours and forty minutes dual flying and twenty minutes solo flying. The greatest altitude reached was 5,000 feet. His Instructor reported that apparently he had no sense of balance and had a tendency to side-slip. He crashed twice in twenty minutes. This case was one of the earliest which was investigated and is a good example in favor of routine examination. His Nystagmus to right and left was 30 and 18 seconds, showing a marked asymmetry. His Pointing and Falling were practically normal.

Case 5- J. E. F.,

This example was taken from an applicant who was rejected on application. His Nystagmus to the right and left was 12 and 14 seconds. Theoretically, from this point alone he should have made a good Balloonist, but this man on turning became markedly dazed, collapsed completely, showed marked vertigo and in fact could not stand for several minutes after rotation. His Pointing Tests were slightly confused and on turning to the right he fell to the left and vice versa, which of course would alone absolutely exclude him from the flying service.

It has been found by the Officer in charge of the "Rotation Tests" that after examination of large numbers of successful pilots who have flown 100 hours and over, that in no case has he as yet discovered a man who has not conformed to the arbitrary standards laid down for admission to the Corps and recognized as normal.

Simple Mastoid operations theoretically should not of necessity prohibit a man from flying, but when one remembers the rapid change of both temperature and pressure to which the pilot is subjected, the continuous roar of the unmuffled exhaust and the rattle of machine guns, it does not seem a sound policy to accept for cadets men who have suffered from mastoiditis or middle ear disease. We have learnt by experience that even a moderate degree of nasal or naso-pharyngeal obstruction, popypi or a deflected septa, which ordinarily would be symptomless, in the pilot who ascends 5,000 feet or upwards produce a definite discomfort or even distress, quite sufficient to interfere with his usefullness. In this connection, it is necessary to keep in mind that a pilot has at all times every sense alert, that he is, even in straight flying, under a certain mental strain, which in

"Aerobatics" and Aerial Fighting looms into immense proportions. With these facts before us we can realise how even the slightest disturbances may become magnified, detract the man's attention from his work and even be the cause of a catastrophe. Not only has the pilot to control his plane, which after he has learned the "Feel of the Air" becomes automatic, but he has according to his duties to sight and release bombs, manipulate his aerial camera, observe the terrain below him, watch the bursting shells, correct the aim of batteries by means of his wireless apparatus, and most vital of all when over hostile territory detect the presence of an enemy before he himself is discovered. Not only must he also become the master of his Lewis and Vicker's Guns and be prepared to use them effectively, but occasionally cast his eye on his instrument board noting his speed-indicator, compass, altimeter, oil and gas gauges, and the revolutions of his engine. It is not to be wondered at that the pilots health must be continually guarded and that even the slightest ailments should receive the most careful consideration and attention that the medical profession can provide, for not only does he hold his own and his observers lives in his hands but often the fate of even whole divisions. That the plane and its master are the eyes of the Commander in Chief has been proved again and again, and as on the Rigger and Fitter rests the responsibility for the condition of the Plane and its Engine, so on the Medical Officer does that of the health of the Pilot and his Observer.

Fainting in the air is probably the cause of an appreciable number of accidents, but this is very difficult to prove for it has the writer's experience that only in most exceptional cases will a cadet who has "crashed" and lost consciousness at the time, remember anything of the period of fall or circumstances leading up to the loss of control. This fact is in itself more an advantage than otherwise, for this often most trying period is completely obliterated from the memory; if it were not it is almost certain that those who have fallen from a considerable height would seldom care to

again pilot a machine, yet it is extremely rare to find a cadet whose previous history is good, to do anything else than beg to again be allowed to fly, sometimes in spite of the most serious injuries. Drowsiness, dozing or even fainting at high altitudes is indirectly due to "Oxygen Want", for almost invariably it is found in experimenting that if the amount of oxygen in the respired air is reduced to a certain percentage the subject will faint quietly with but few premonitory symptoms, which follow one another with startling rapidity. Outside of those causes already mentioned organic diseases, digestive disturbances, fatigue and loss of general muscular tone, particularly in the muscles of the abdominal wall may readily cause syncopal attacks. Splanchnic Flooding or abdominal congestion is probably always present in the above class of case and the writer is of the opinion that apart from the advantage of keeping the "Safety Belt" on moderately tight from the point of view of security, its presence may well be a factor in preventing a sudden or too pronounced mesenteric congestion. Attacks of vomiting in the air due to temporary disturbances may easily terminate in loss of control of the plane and in some cases even in syncope, so that it is the duty of every Medical Officer to watch closely and daily the men under his care and at the slightest appearance of fatigue or illness to prohibit their flying, even should they have complained of no symptoms nor reported their indisposition. Certain cases have been recorded where the pilot has apparently fainted, and after gliding down or "spinning" for considerable distance, has ultimately regained consciousness and control of his machine in time to avert a "crash", one good example of the advantage of flying at a considerable height. The effect of continuous flying at even moderately high altitudes in intensely Cold atmosphere may on occasion render a man drowsy and result in momentary loss of consciousness. The writer has seen this occur in pilots who have left the ground at a temperature of from 15 to 20 degrees below zero and have gone only to a height of from 6,000 to 8,000 feet without untoward results. It is well to note in this connection that the temperature of the air falls

fairly constantly 3° F. for each 1,000 feet of altitude. It is possible that four alone may produce a definite fainting attack. The cause and treatment of syncope shows how necessary it is to see that proper Physical Training is carried out both for cadets and instructors, and let me point out that it is just as important for the latter to be kept in good condition as for their pupils. In order to obviate the possibility, in some cases at least, of a pilot falling forward on his controls or "joy-stick" during a fainting attack or when vomiting, and so putting his plane into a "spin" or dive, the "safety-belts" have recently been raised, so that instead of crossing the body at the pelvic girdle they are now some 6" higher and thus support the body against the back of the seat. Vomiting in the air is frequently seen and we may divide the cases into two groups, those in which the difficulty is transient and may be overcome, and secondly the incurable type. It should be pointed out here that a passenger, particularly if in the front seat of a machine, may readily be made to vomit on being "stunted" violently, in fact even an experienced pilot can be made extremely uncomfortable by continuous "zooming", if he is taking no part in the control of the machine. There are certain cases allied to ordinary "sea-sickness" where nausea and vomiting disappear as the cadet becomes used to the "bumps" and movements of the plane, and it should be noted that these men often prove to be excellent pilots; on the other hand vomiting associated with organic disease of the internal ear is almost invariably incurable. Most cases of emesis however may be traced to simple digestive disturbances, and are not infrequently associated with a distinct nervous element in new cadets. Active purgation, exercise, a strict dietetic regime, with in the nervous class a short leave, will usually cure this condition. It has been noticed that those cases which prove most intractable are the ones in whichthe emesis occur after reaching the ground; this, however, is not an absolute rule. Vomiting due to disease of the Labyrinth of the Ear is readily detected and may be

considered incurable from the airman's point of view, the rotation tests of course will at once differentiate this type from the others less serious.

The Eye in relation to flying presents certain problems which have a practical bearing on the subject. Cadets are examined previous to enlistment and attested only after a certificate is given stating that an eye has 6/6 vision and the other at least 6/12, and that no Astigmatism of any consequence is present. Strabismus or other gross defects of course would in every case reject the candidate. In view of the relatively high standard required, actual visional defects developing after enlistment are not common. but a certain number of cases pass the examiner who have definitely defective vision; usually these men have committed the tests to heart or by deceit, which in a sense is almost laudatory have succeeded in passing the examination. Defective accomodation causing complaint of eye strain due to fatigue of the ciliary muscles is a fairly common trouble, it is usually if not always associated with a general loss of neuro-muscular tone. No man showing Astigmatism to any extent should be allowed to fly; firstly, because of the extra strain imposed on his ocular mechanism with its consequent early muscle fatigue and accompanying headaches; and secondly on account of the difficulty experienced in landing on an "even keel" with the wings parallel to the ground surface. Many "landing crashes" have been traced to this latter cause and also to Heterophoria, although the pilot may have no difficulty in flying at an altitude where he relies on his auditory labyrinth. Tests for the presence of normal "Stereoscopic Vision" are useful, but providing that the standards above outlined are kept up, it would be extremely rare to find an accepted candidate who could not "stereoscope" properly. Again from a practical point of view it should be remembered that the most vital and most difficult duty the fighting pilot has to perform is the sighting of his gun and that this is a uniocular action, and may I note here that there are a number of pilots fighting in France with but one eye.

The question of whether glasses should be worn under the goggles has been frequently debated. The writer feels most strongly that they never should be used, except by pilots already trained or those who have developed defects during their course, and also that under no consideration should they ever be used on active service. The discomfort and irritation often found alone should prohibit their use, and also the possibility of their displacement, loss or "steaming" must be born in mind. The glasses of the goggles may be ground, but this is also in the writer's opinion a doubtful practice, especially in Canada where sufficient applicants with normal vision are still available. Not only the difficulty in grinding "cylinders" must be met, but also the fact that goggles to be effective must allow of as great a lateral range as possible in order to increase the "field of vision". To accompolish this the lenses are usually placed, not at right angles to the antero-posterior axis of the plane, but at an angle with the outer margin inclined backwards, so that the difficulties to be overcome in artificially correcting visional defects with any degree of accuracy are almost impracticable. It is a bad practice to fly without goggles on account of the possibility of getting fine oil droplets into the conjunctional sac and also on account of the irritation set up by the force of the propellor "slip stream". Perfect "Color Vision" is not essential but both pilots and observers must have accurate impressions of the primary colours especially for signalling and "forced landings". Considerable attention has been recently drawn to the subject of Heterophoria or "Latent Squints" which have appeared in pilots as the result of the continuous eye muscle strain experienced on active service. In Canada the problem has been negligable, but reports from abroad show that it is sufficiently frequent there to require special attention, in fact a centre has been established and equipped to provide these cases with the proper treatment and prismatic muscle exercise. We must not forget that many of these cases under normal condition would never have become apparent, that the loss of "muscle balance" results largely from fatigue and that

this often is only a symptom of a general neuro-muscular asthenia. The term Heterophoria is used to express any latent ocular muscle deviation and its extent is measured by means of prisms. Hyperphoria is the tendency of one visual axis to turn above the other, Esophoria to excessive convergence of the axes and Exophoria to their divergence. In additionto the difficulties complained of resulting directly from defective vision secondary symptoms such as headaches, vertigo, blurring of vision and even nausea or vomiting must be considered, and wherever they are encountered and no other cause can be found a careful examination of the ocular apparatus must at once be undertaken.

It has been noted on active service in pilots who have been flying for long periods with little or broken rest, under severe mental strain and at altitudes of from 15,000 to 20,000 feet, that not infrequently certain distressing symptoms make their appearance. It was first thought that the dyspnoea, vertigo, blurring of vision, rapid pulse, headaches, palpitation, syncope and signs referable to the vaso-motor system were due chiefly to changes in atmospheric pressure. It is largely to the Medical Research Committee of R.A.F., that it has finally been proved that such disturbances result directly and solely from the effect of the lowered percentage or tension of Oxygen found in higher altitudes, or to what is now alluded to as "Oxygen Want"

Table of approximate
Oxygen percentages at various altitudes

8,000	feet	altitude,	..... -	15.5%	Oxygen
12,000	"	"	..... -	13.2%	"
16,000	"	"	..... -	11.0%	"
20,000	"	"	..... -	10.0%	"
23,000	"	"	..... -	9.0%	"

As has been noted previously in this article simple lowering of pressure in the atmosphere surrounding the body, providing that the change is gradual and that oxygen is administered to the subject in sufficient quantity to supply his needs, is void of untoward physical effects. Again two normal pilots may be subjected to the same amount of physical or mental strain and altitude in flying; if one of them however be supplied with Oxygen while in the air, it has

been found that he alone will experience little discomfort and will develop no abnormal symptoms; so that the hypothesis suggested above is abundantly supported by facts. As a result it is proposed to supply the pilots of all machines having a "ceiling" of over 10,000 feet with oxygen tanks for intermittent inhalation and also to administer it for a short time to men after long trying flights of any altitude. The symptoms of "Oxygen Want" are seldom complained of by pilots during the earlier weeks of their altitude flying, for nature apparently is either able to compensate to a considerable extent in healthy men, or the symptoms are so slight as to be disregarded until fatigue sets in and it is usually only after this compensating action begins to fail and the cumulative effects to appear that these become distressing. An immense amount of laboratory research is now in progress on "low pressure or pneumatic chambers", "rebreathing tanks", "nitrogen dilution" experiments, etc., and are beginning to show results, which will undoubtedly prove of practical value, not only in the assessing of results, in the selection of the altitude beyond which a man should not ascend, but also in determining the date on which a pilot, already a sufferer from "Oxygen Want" and "stress of flying" may return to his squadron for duty. At present it is impossible in Canada to apply such intricate tests to candidates for cadet pilots owing to exigencies of war and the paucity of Medical Officers, but in order to gain some index to a man's vital capacity and stamina, we observe the time during which a man can hold his breath. When this period falls much below 45 seconds we rarely accept the applicant, as one who will probably not stand altitude flying, will "wear badly", suffer from "oxygen want" and who will, so unlikely to prove an efficient pilot with satisfactory "staying power". In this test the subject should first expire deeply once, then hold the breath in a sitting position. The nose should be held or clipped and if too much air has been inspired it may be allowed to escape, but no fresh air must be inhaled during the experiment. The above procedure must be repeated at least three times in order to eliminate the possibility of an error. It is impossible

here to detail the methods used or the results obtained in the experiments mentioned above, suffice it that generally whatever apparatus is used the results are strikingly similar. The subject is gradually deprived of the normal percentage of oxygen in the air with which he is supplied, at a rate which corresponds roughly to that found in the atmosphere through which he would pass in a plane climbing approximately 1,000 feet per minute. Usually nothing abnormal is noticed until at least 5,000 feet is reached, except that there is a slight but gradual increase in the pulse rate. Later the systolic blood-pressure begins to rise slowly, the respiratory excursions to become deeper and more frequent, slight giddiness, specs before the eyes, inattention, mental inefficiency, and towards the end of the experiment signs of drowsiness, circulatory failure, cyanosis and final syncope appear. The result of the experiment gives us the maximum altitude to which it is possible for the subject to ascend and the percentage of Oxygen he requires in order to fly without danger, and on this is based the report ~~hereby~~ with ~~such~~ on his classification as a pilot, in so far as it effects the height at which he should be allowed to fly. Certain psychological experiments are being carried out simultaneously with these described above, but it is as yet too early to draw deductions, since practically all the subjects used up to the present have been presumably normal men. Determination of what has been called "Reaction Time" is tested in many ways; one method for example being through the sense of sight. The person under investigation presses a telegraph key, the moment he sees the flash of an electric bulb, an electrical contact is set up simultaneously with the appearance of the light which starts the second hand of a stop-clock on its circuit, this contact is again broken by the pressure of the key so that the interval in fractions of a second can be readily measured and this interval is called "Reaction Time" The "Domino" test is also used for similar purposes. Similar experiments are made syncronously with those described above in connection with the reduction of the Oxygen tension in order to ascertain the variation in the "Reaction Time" at different altitudes.

It is unfortunate that these experiments cannot be carried out as yet in the air during actual flight, but conditions so similar can now be produced artificially, even to alteration in pressure and temperature, that the results obtained closely approximate those which would be found in active service. The writer regrets that owing to the ceiling of the Curtiss Aeroplane, unusually used in training on Canadian aerodromes, being only 10,000 feet it has been impossible to carry out original researches on altitude work in this country The reports of the M.R.C., (No.3) gives in elaborate tables, the results arrived at from certain tests applied to "Stale" pilots returned from France. The "Stress of Flying" from which such men suffer is probably in the writer's opinion the result of the combination of several factors, the chief of which are asthenia of the neuro-muscular system, "brain fatigue", "oxygen want" and the strain imposed on the cardio-vascular system by repeated efforts to compensate for the rapid and marked changes which the respiratory centre and apparatus are subjected in altitude flying. The subjects of "Flying Stress" in England are carefully examined in regard to several important points. (A) "Breath Holding" has already been described, and if properly carried out gives very valuable results, the normal pilot averages from 65 to 70 seconds. (B) Tests for "Vital Capacity" are also made and as a result it has been found that the average normal capacity of a healthy man is 3.900 c.c. and that those who run under 3.000 c.c. almost invariably show some abnormal signs or symptoms and are ineffective pilots. This experiment is carried out by simply instructing the candidate, after taking a full breath, to exhale to the full extent into a well made gas-meter. (C) "Supplemental Air" is also measured by means of a meter, normally approximates 1.500 c.c. and means the amount of air remaining in the lungs which can be exhaled by quiet expiration during a period of normal breathing (D) "Complemental Air" is determined by instructing the subject, during quiet breathing and after an inspiration, to inhale and fill his chest to the limit; which procedure is simply the reverse to that used in the previous experiment. This test however is not in general use owing

to sanitary objections. (E) The "Expiratory Force" is measured by blowing up a column of mercury contained in a simple "U" tube the result being measured in millemeters of mercury, it normally averages 115 m.m. Hg. (F) The subject is next told to fill the chest and blow the mercury up to the 40 m.m. mark and keep it at that level for as long a period as possible. This period has been found to be approximately 52 seconds in normal pilots. Lt.Col.Martin Flack is of the opinion that Flying Officers showing signs of "stress" are first unable to comply to the condition of test (F) described above and that as the "stress" becomes more marked the others also gradually become effected and the respiratory capacity to fail. He suggests that test (F) in particular may prove of value in differentiating cases of "anxiety neurosis" who usually pass the tests well from those cases of true "stress" resulting from the strain of flying, or from those cases who suffer from real disabilities such as would confine a man to hospital. It will probably also prove useful in "assessing the degree of shock sustained by a pilot in the so-called minor crashes", in differentiating these from simple "aerophobia" and in the classification of pilots having special regard for their high flying qualities. It is interesting to note before leaving the subject of "oxygen want" that a history of "Cheyne Stokes" breathing is not infrequent in pilots during long and high flying, that they usually become "mouth breathers" after 10.000 feet, also that not infrequently those apparently least qualified from a purely physical standpoint have proved even famous "war pilots", but these it is true have been endowed with more than ordinary "nerve", fearlessness and mental attributes denied to their fellows and are "born rather than made"

A number of tests are also applied designed to give an idea of the degree of nervous stability possessed by the subject; one for example consists in getting the man to draw a long straight line on a sheet of paper and unexpectedly startling him with a loud noise, the amount of deviation noted in the line at that moment being taken as a rough indication of the condition of his "nerves", simultaneously pulse tracings are also often taken to show the effect on the heart.

Since most ofthese reactions are used to eliminate undesirable recruits I do not propose to deal with them in these notes. Drowsiness resulting from flying in the intense Cold has already been alluded to on page 17,the sense of comfort preceding it should at once warn a pilot of its onset and is a danger sign not to be neglected. No practical difficulty was experienced in flying in Canada last winter; broad "skis" replaced the wheels on all machines and since the snow during the greater part of the winter converted practically every field into an ideal landing ground, even "forced landings" were easily made. Early in the winter considerable difficulty was experienced with cases of frozen cheeks in spite of the use of various oils and ointments, most of which fronze in situ; this difficulty was however overcome most effectively by issuing chamois face masks fitted with orifices for the eyes and mouth. Few cases of frost bites in hands and feet were reported among pilots, but these were frequent enough among the mechanics engaged in ground duties. The gauntlets and thigh "flying boots" supplied to pilots were most effective in preventing frost bites. Machines were flown at a ground temperature of - 35° F., the author himself having left the aerodrome with the thermometer standing at 22° below zero, but in spite of this intense cold no casualties directly due to low temperature were encountered during the whole of last winter. The problem of the classification of pilots with reference to the type of machine or particular duties to which they are most suited is a practical one and should in my opinion be solved in a consultation between the Medical Officer, the Squadron Commander and the cadet's Instructor. The "temperament" of one man for example might be such as to render him of little use in a Scout; on the other hand he might prove invaluable in an Artillery Co-operation or Bombing Flight or as a "Ferry Pilot" Some pilots have a most delicate sense of poise and "feel of the air" while others are "heavy handed", the former of course should be

allotted to a squadron of fast machines and the latt[er] to a "Handley-Page" or a "Seaplane". Again the [q]uestion of the altitude above which a pilot should not fly continuously requires attention. Whether or not a pilot should fly alone or always in "Formation" depends largely on his individual psychological and temperamental characteristics. Some men apparently are quite at home when flying in company but to a certain extent lose that complete confidence which a successful pilot must possess when flying alone. The whole subject of classification is one which well deserves not only the attention of the Flying Instructors but also that of the Medical Officers, who frequently are in possession of facts unknown to the former. In conclusion let me emphasize the necessity for treating every case of "Air Sickness" as an entity, not merely being satisfied with making a simple diagnosis but remembering always that bearing which Psychology has, even in what may seem a purely physical phenomenon, giving it is full due and value before adopting any plan of treatment or arriving at any definite conclusion.

Before concluding these few unscientific notes which are primarily intended merely as a guide to the newer Medical Officers of the R. A. F., may I express my appreciation of the unfailing support and interest taken in all medical problems by the Flying Officers, and my regret that the Medical Staff, owing to the fewness of their numbers and the limitation of the Curtiss Plane, have been able to add so little to the study of "Air Sickness" and particularly of "Altitude Flying"

November 27th, 1918

Major Prefney O'Reilly,
Royal Air Force,
Toronto.

Dear Major O'Reilly:

Yesterday I received your notes on Air Sickness but have had time only to glance at the first page or so of them. I am afraid that for the rest of this term I have so many engagements and have so much to write myself that I shall have very little spare time to go through them. I will keep them beside me and as soon as I get an opportunity I will be glad to read as much as I can. I am sure that your experience with the Royal Air Force will have been most valuable.

Yours sincerely,

President.

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January 31st, 1919

Major H. O'Reilly, C.F.E.,

S.M.C.,

Royal Air Force, Toronto.

Dear Major O'Reilly:

I am sending your letter on to the Bursar and recommending to the Board of Governors that you be granted leave of absence.

Will you allow me to take this opportunity of congratulating you on receiving the decoration of account of your service in the Royal Air Force? It must be a great pleasure for you to have your work thus recognized.

With kind regards, I am,

Yours sincerely,

President.